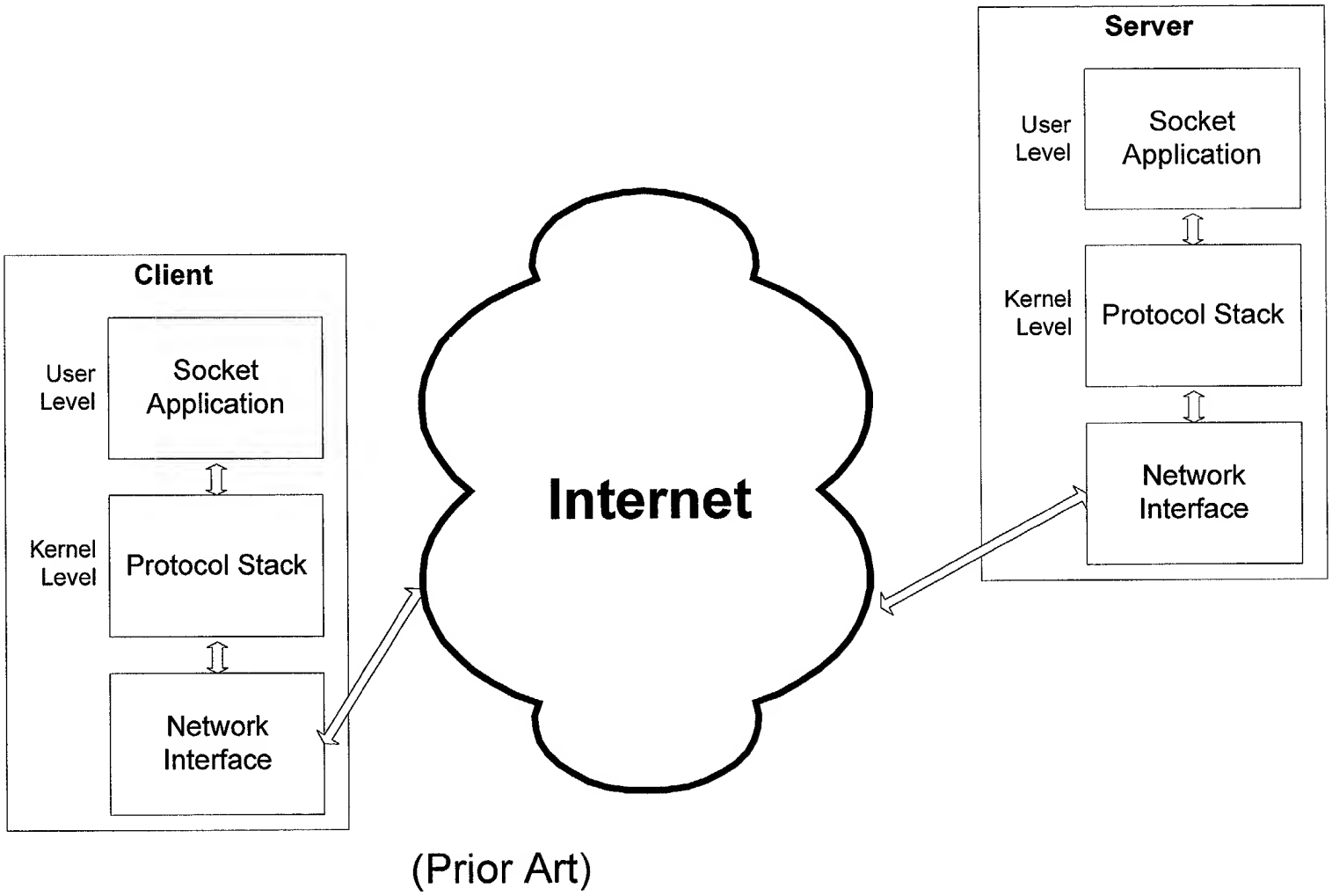


(Prior Art)

Figure 1a

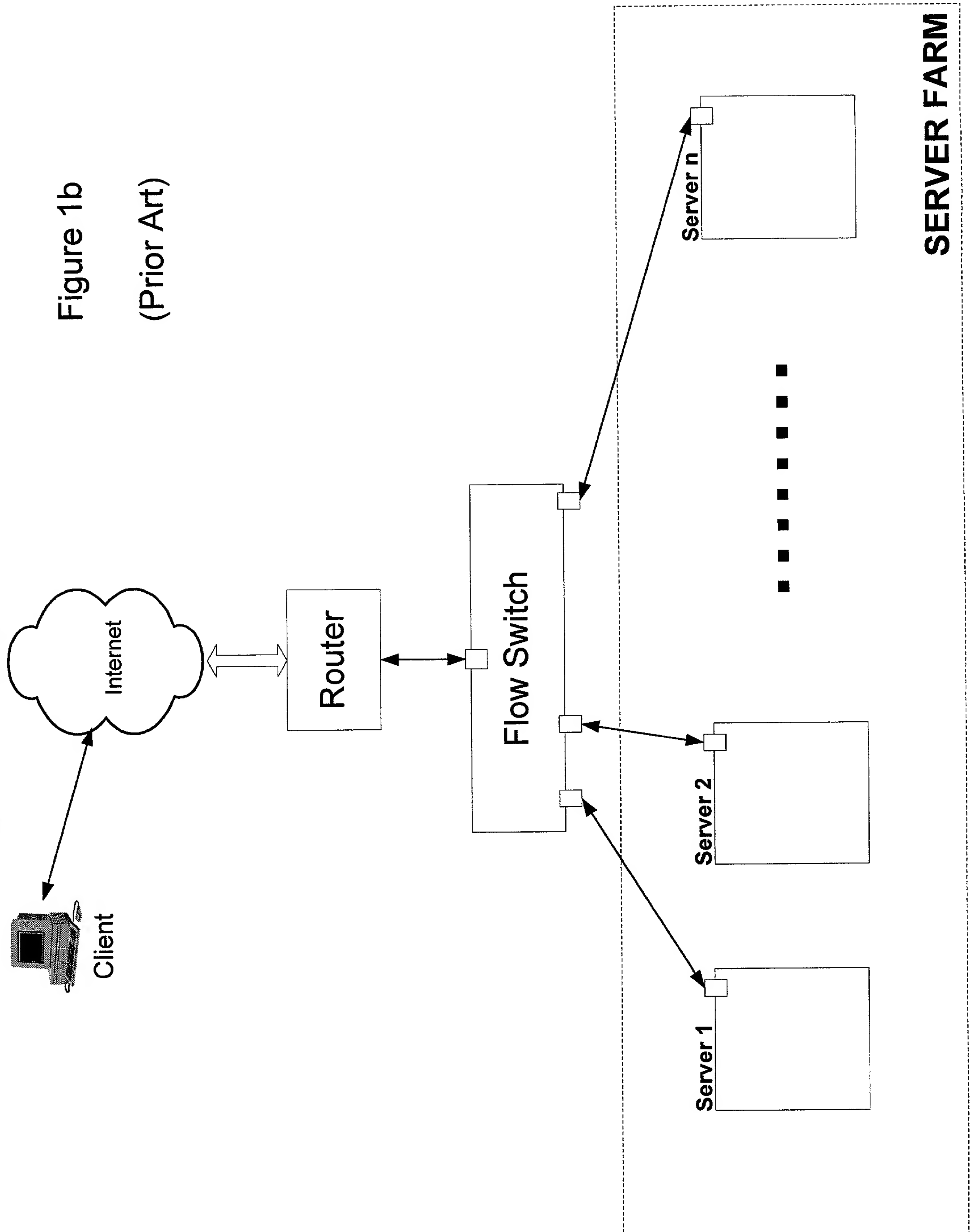


Figure 1b

(Prior Art)

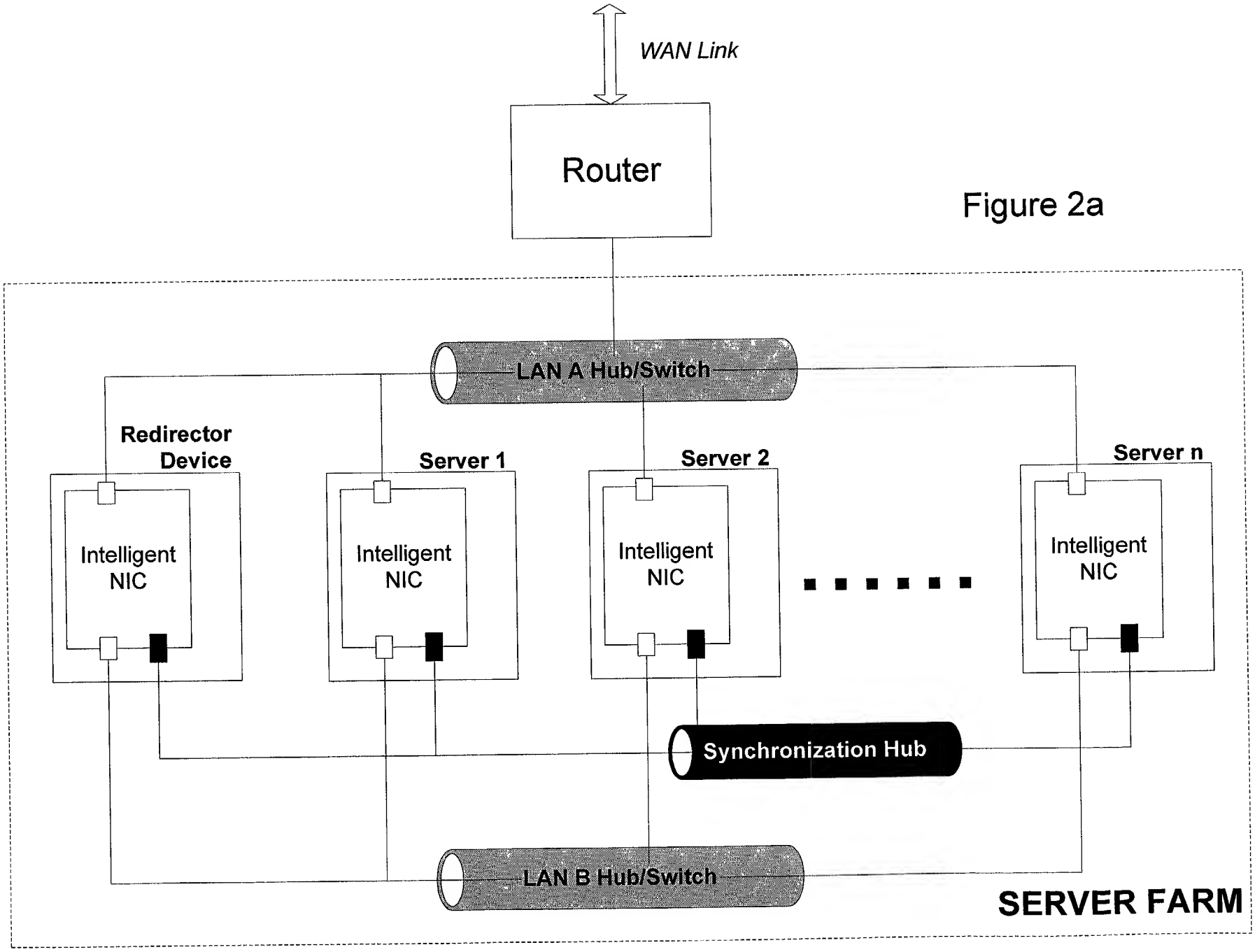


Figure 2a

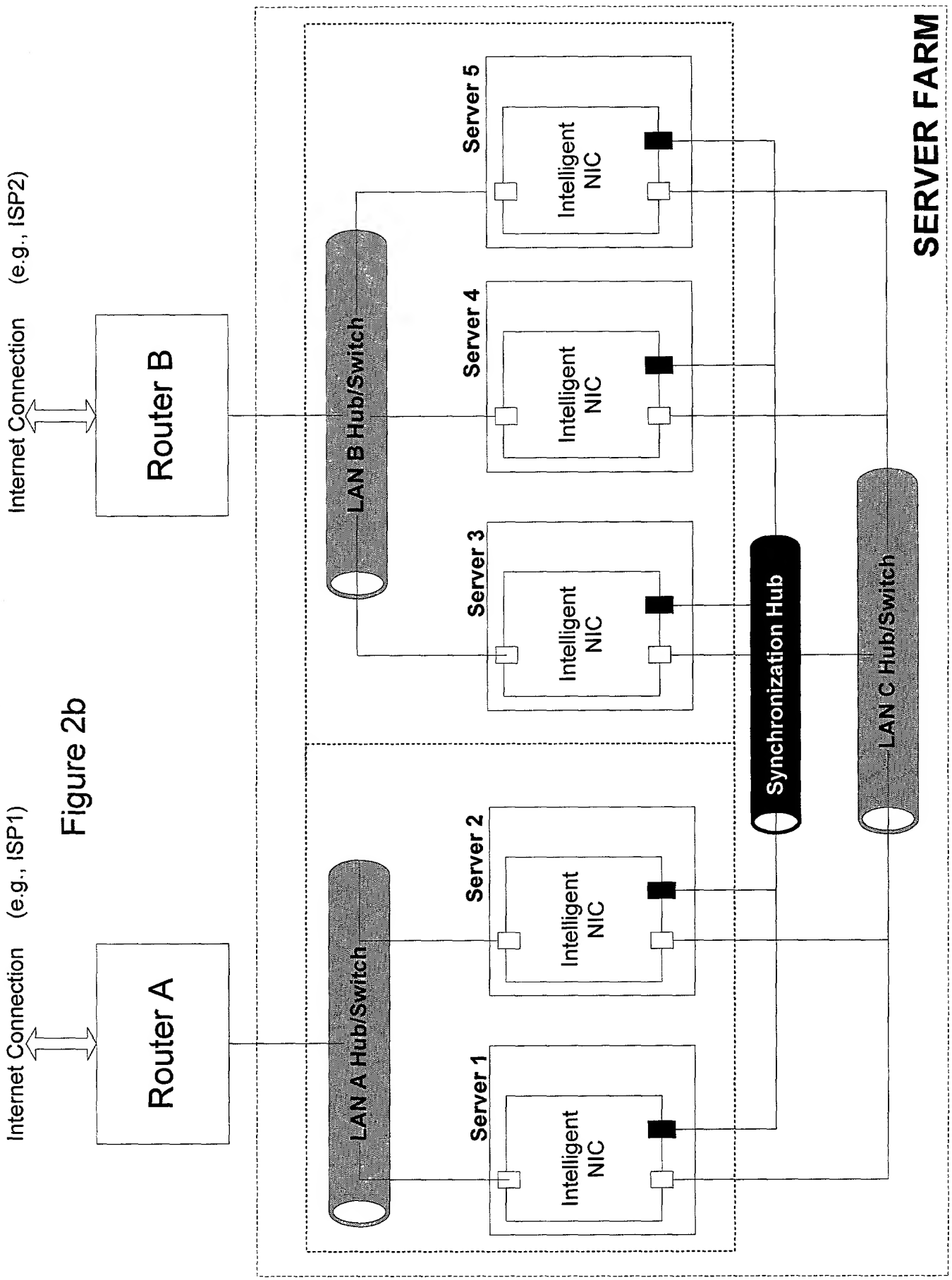

Internet Connection (e.g., ISP1)
Router A
Internet Connection (e.g., ISP2)
Router B
LAN A Hub/Switch
LAN B Hub/Switch
LAN C Hub/Switch
Synchronization Hub
Server 1
Server 2
Server 3
Server 4
Server 5
Intelligent NIC
SERVER FARM

Figure 2b

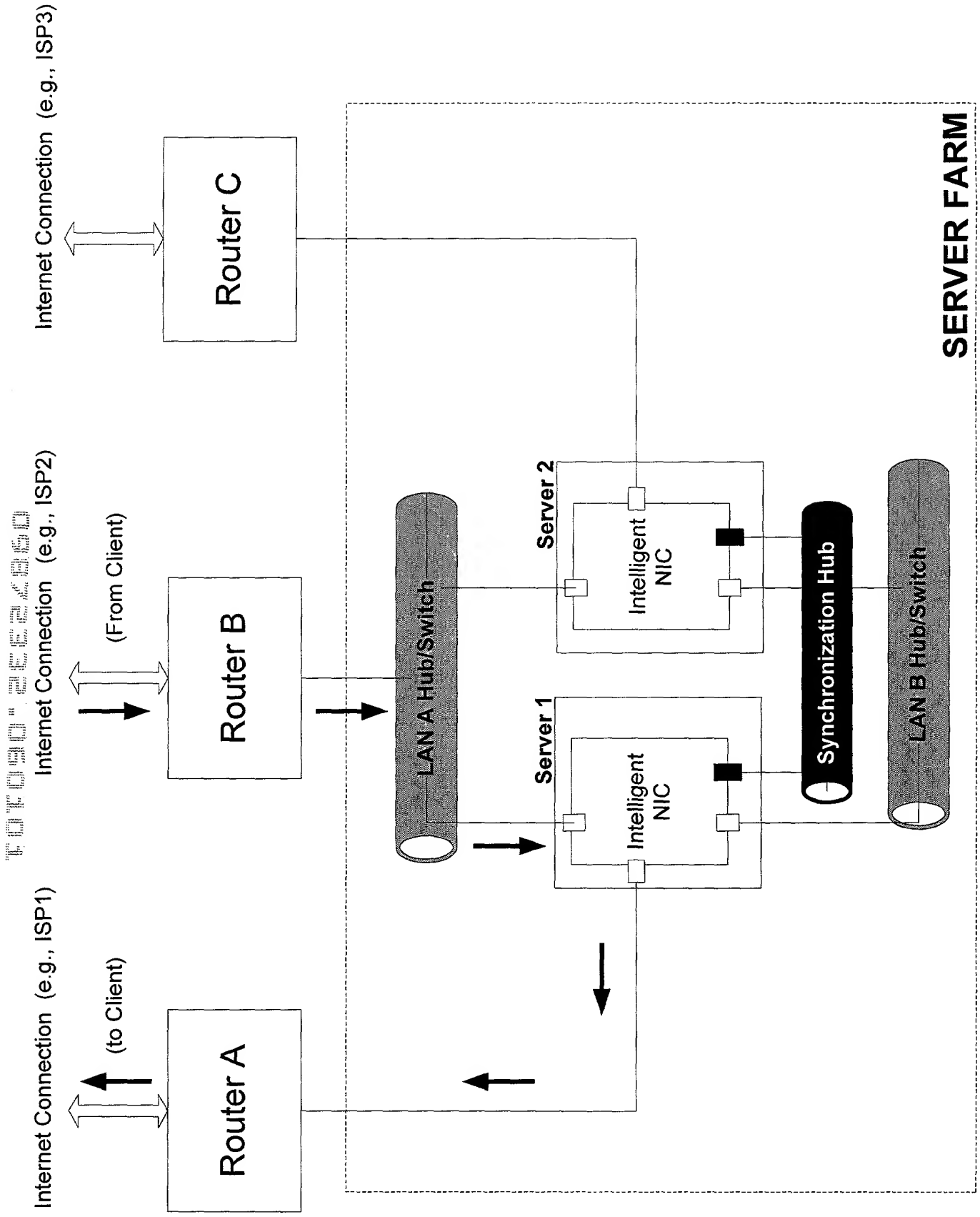

Internet Connection (e.g., ISP3)
Router C
Internet Connection (e.g., ISP2)
(From Client)
Router B
Internet Connection (e.g., ISP1)
(to Client)
Router A
SERVER FARM
LAN A Hub/Switch
Server 2
Intelligent NIC
Server 1
Intelligent NIC
Synchronization Hub
LAN B Hub/Switch

Figure 2c

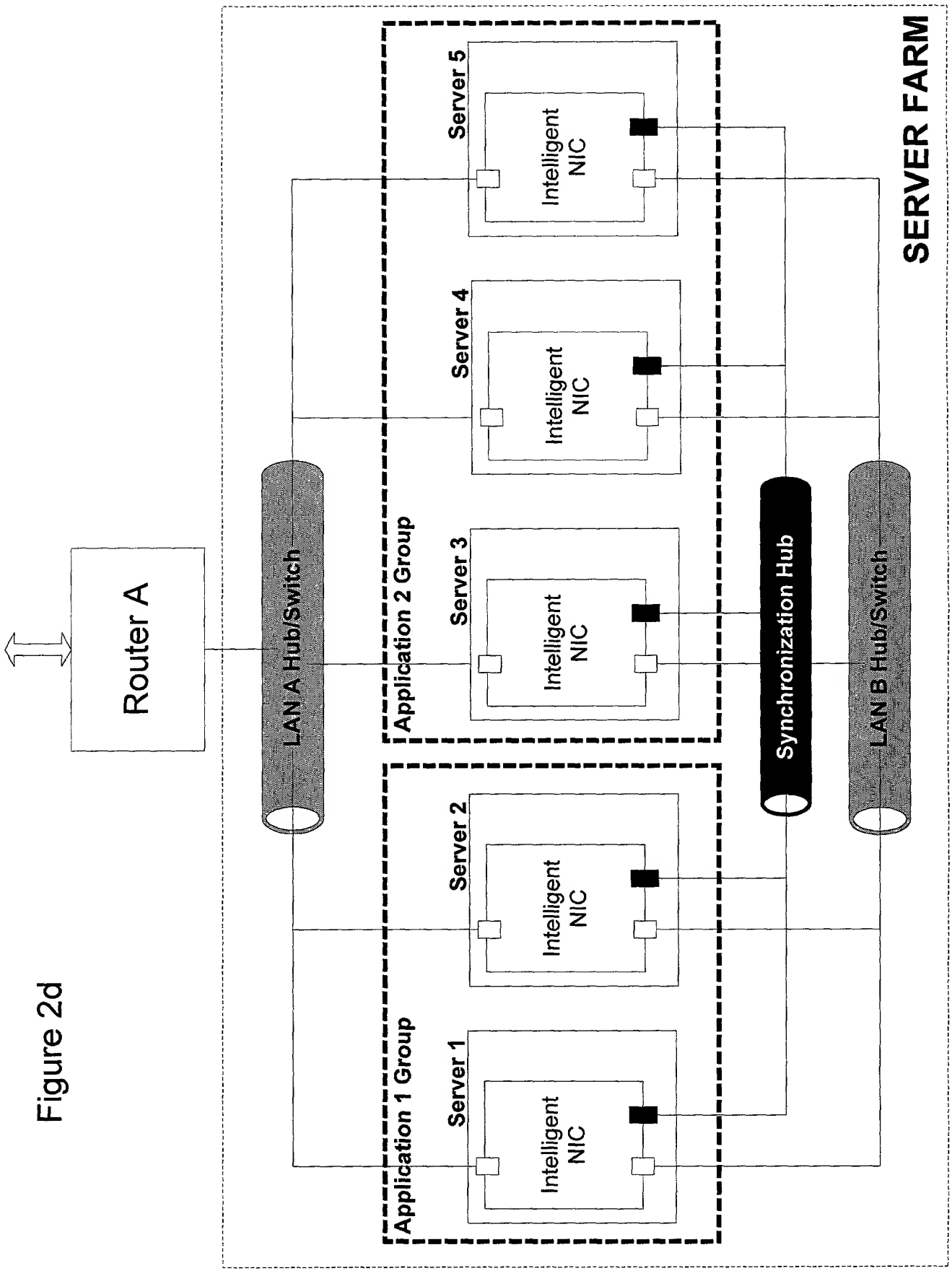

Internet Connection
Router A
LAN A Hub/Switch
Application 2 Group
Server 5
Intelligent NIC
Server 4
Intelligent NIC
Server 3
Intelligent NIC
Synchronization Hub
LAN B Hub/Switch
Application 1 Group
Server 2
Intelligent NIC
Server 1
Intelligent NIC
SERVER FARM

Figure 2d

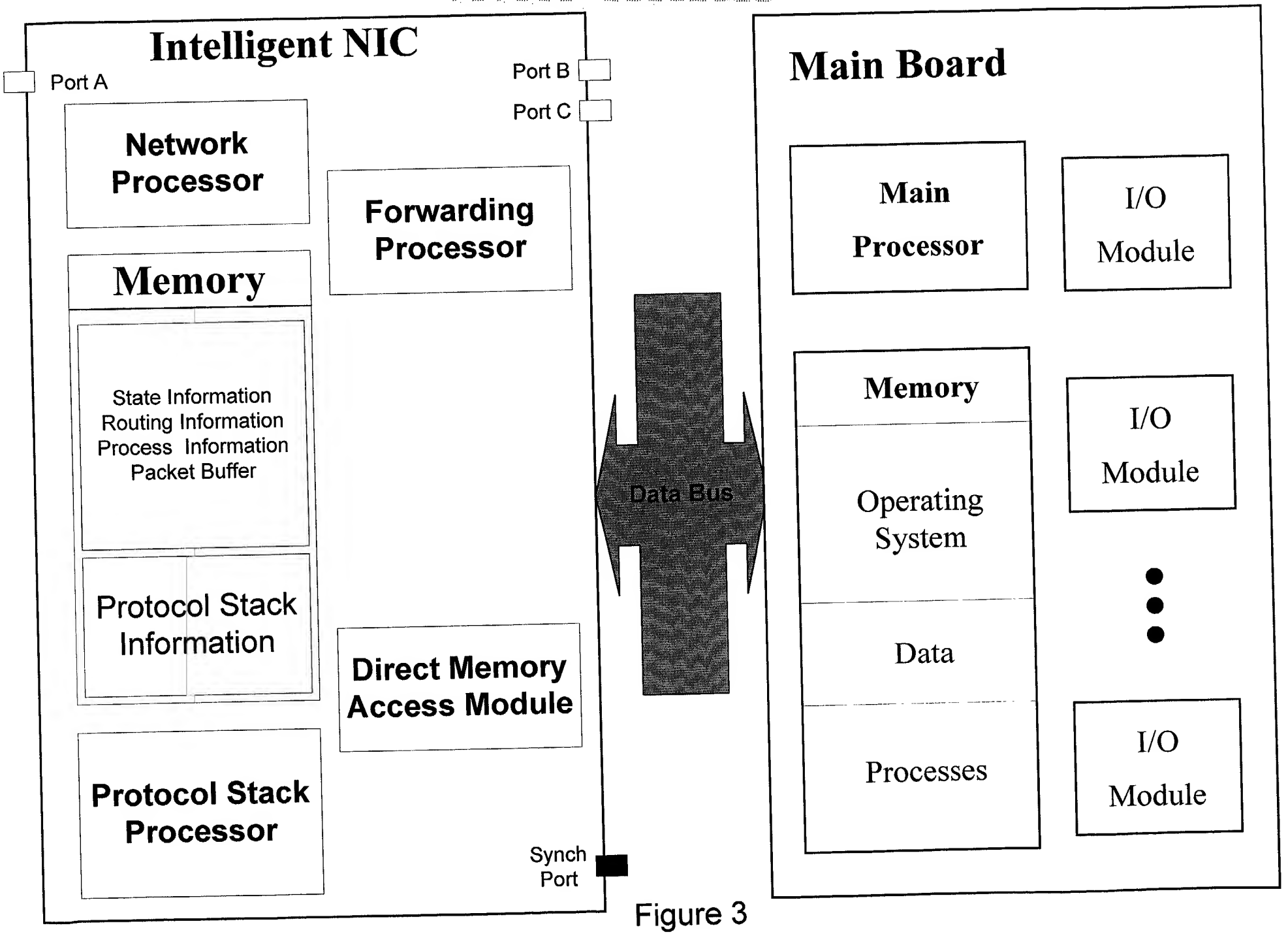


Figure 3

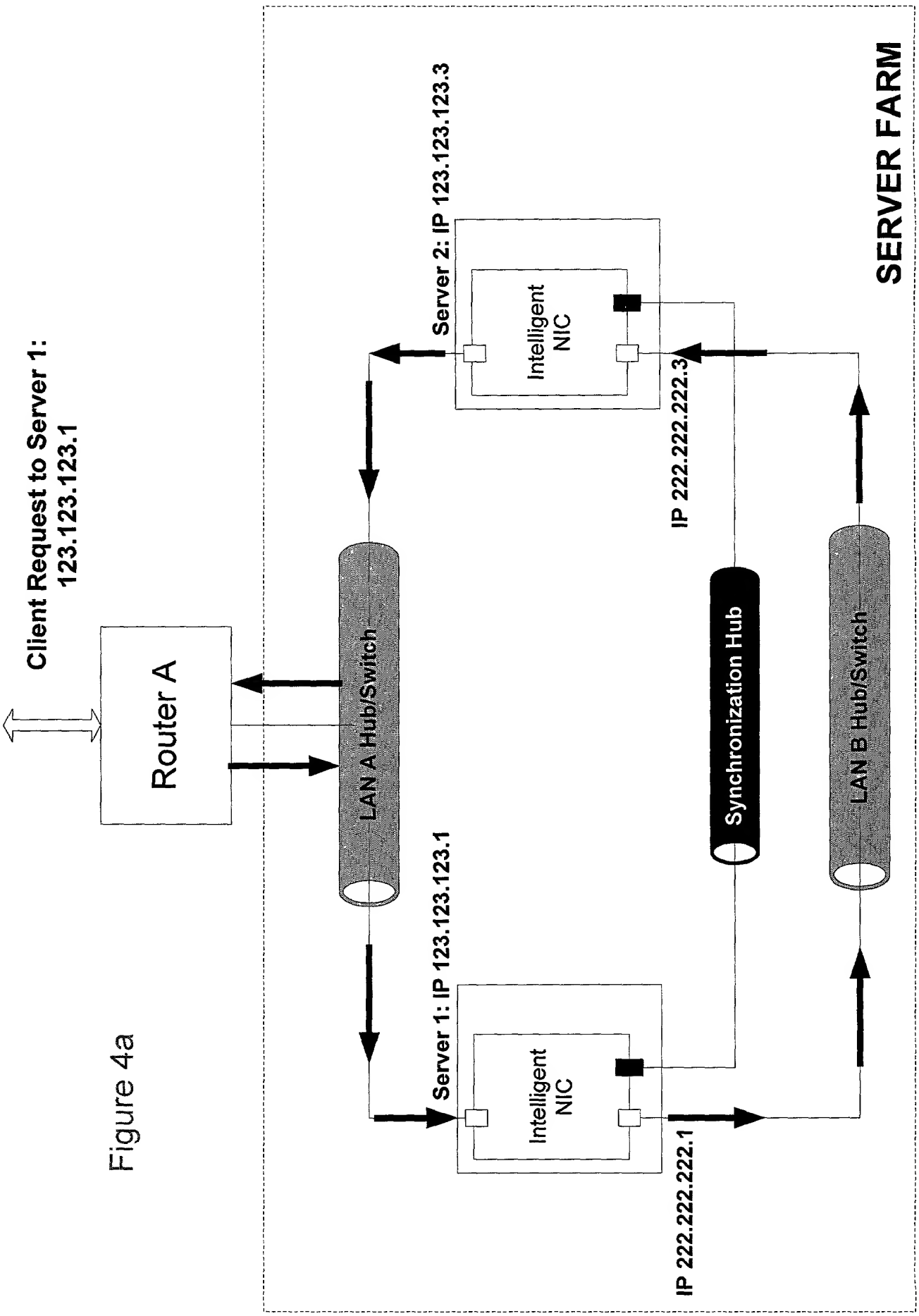

Internet Connection
Client Request to Server 1:
123.123.123.1
Router A
LAN A Hub/Switch
Server 2: IP 123.123.123.3
Intelligent NIC
IP 222.222.222.3
Synchronization Hub
LAN B Hub/Switch
SERVER FARM
Server 1: IP 123.123.123.1
Intelligent NIC
IP 222.222.222.1

Figure 4a

Figure 4b

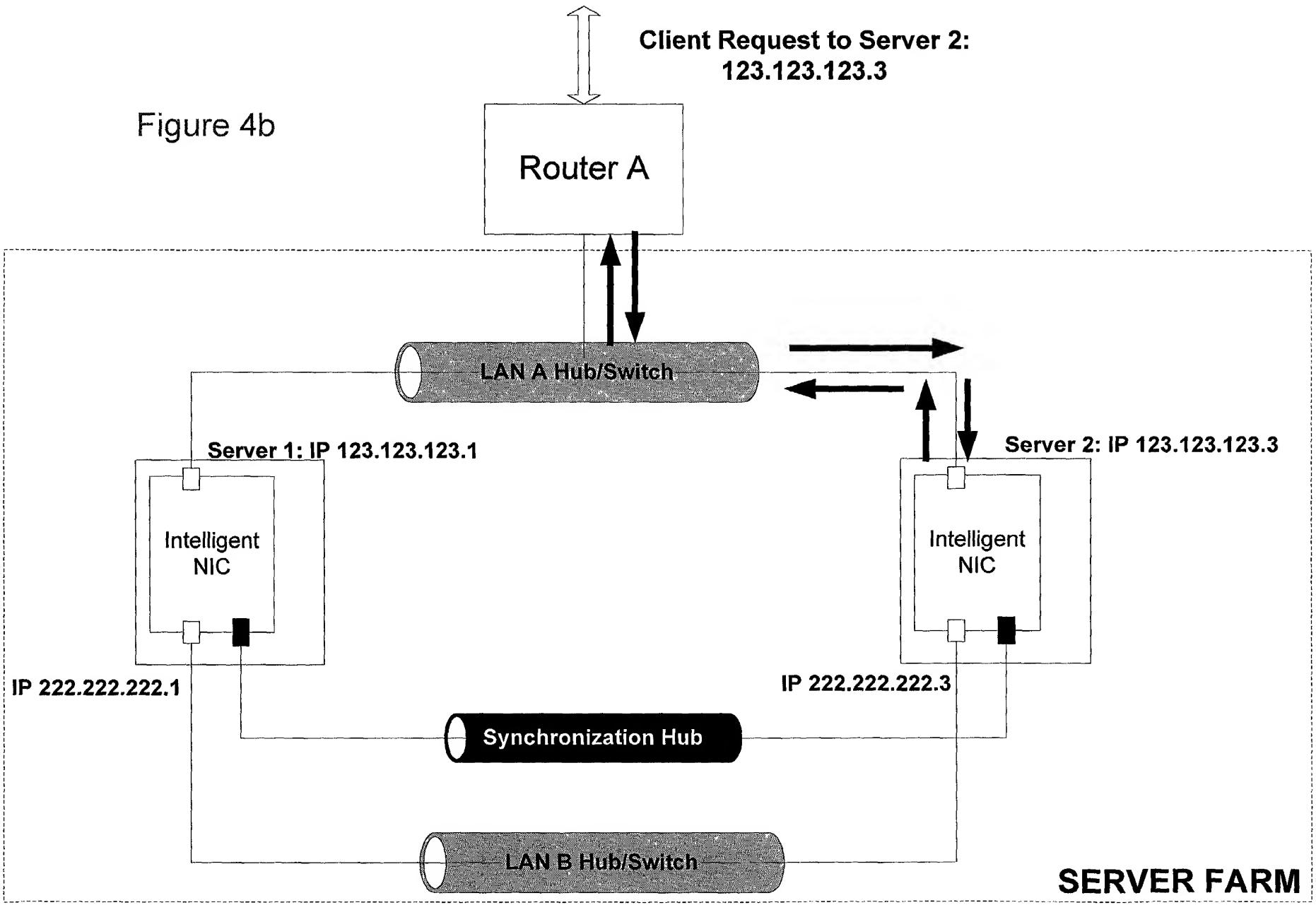
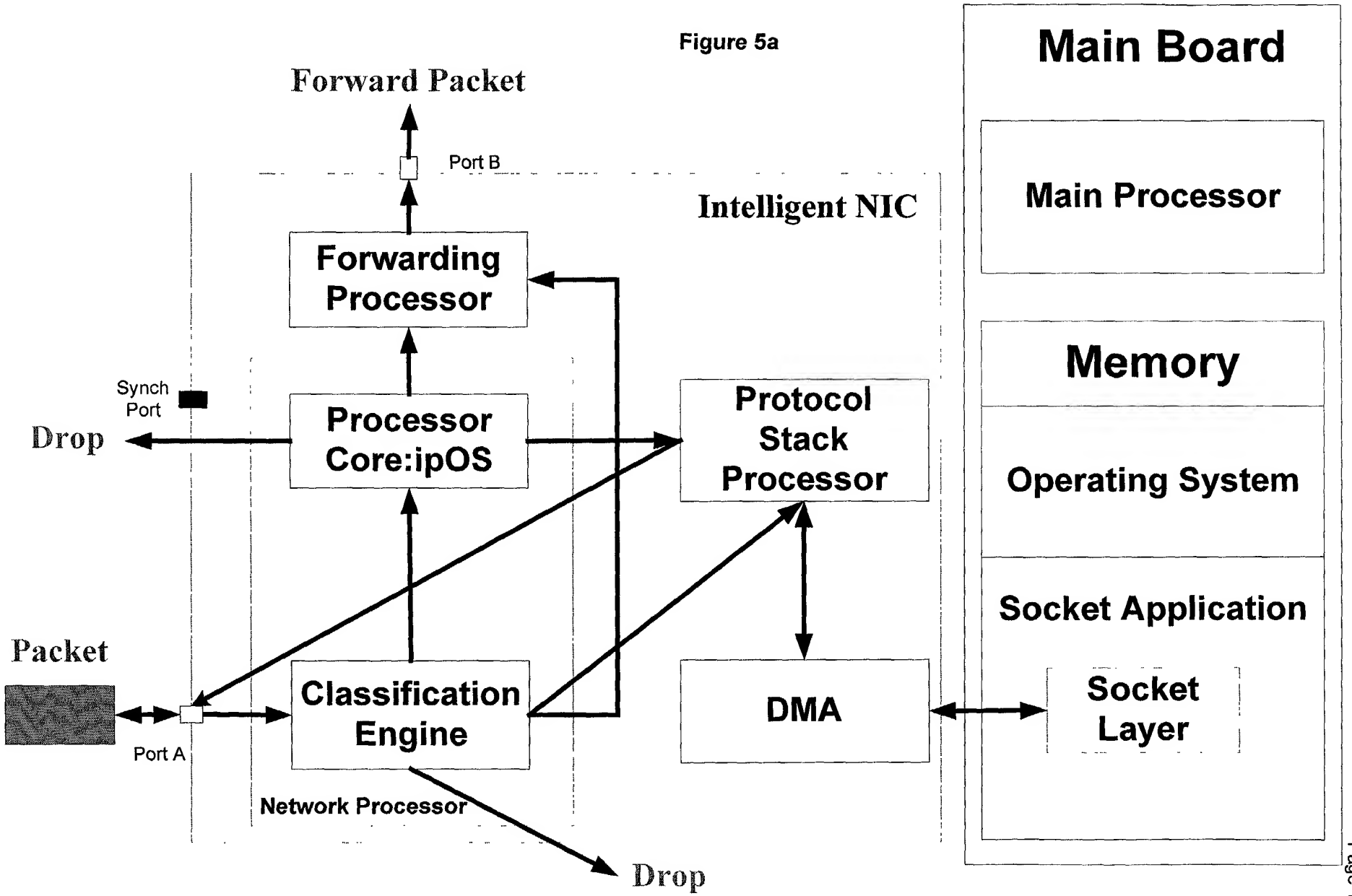


Figure 5a


Main Board
Main Processor
Memory
Operating System
Socket Application
Socket Layer
Forward Packet
Port B
Intelligent NIC
Forwarding Processor
Synch Port
Drop
Processor Core:ipOS
Protocol Stack Processor
Packet
Port A
Classification Engine
DMA
Network Processor
Drop

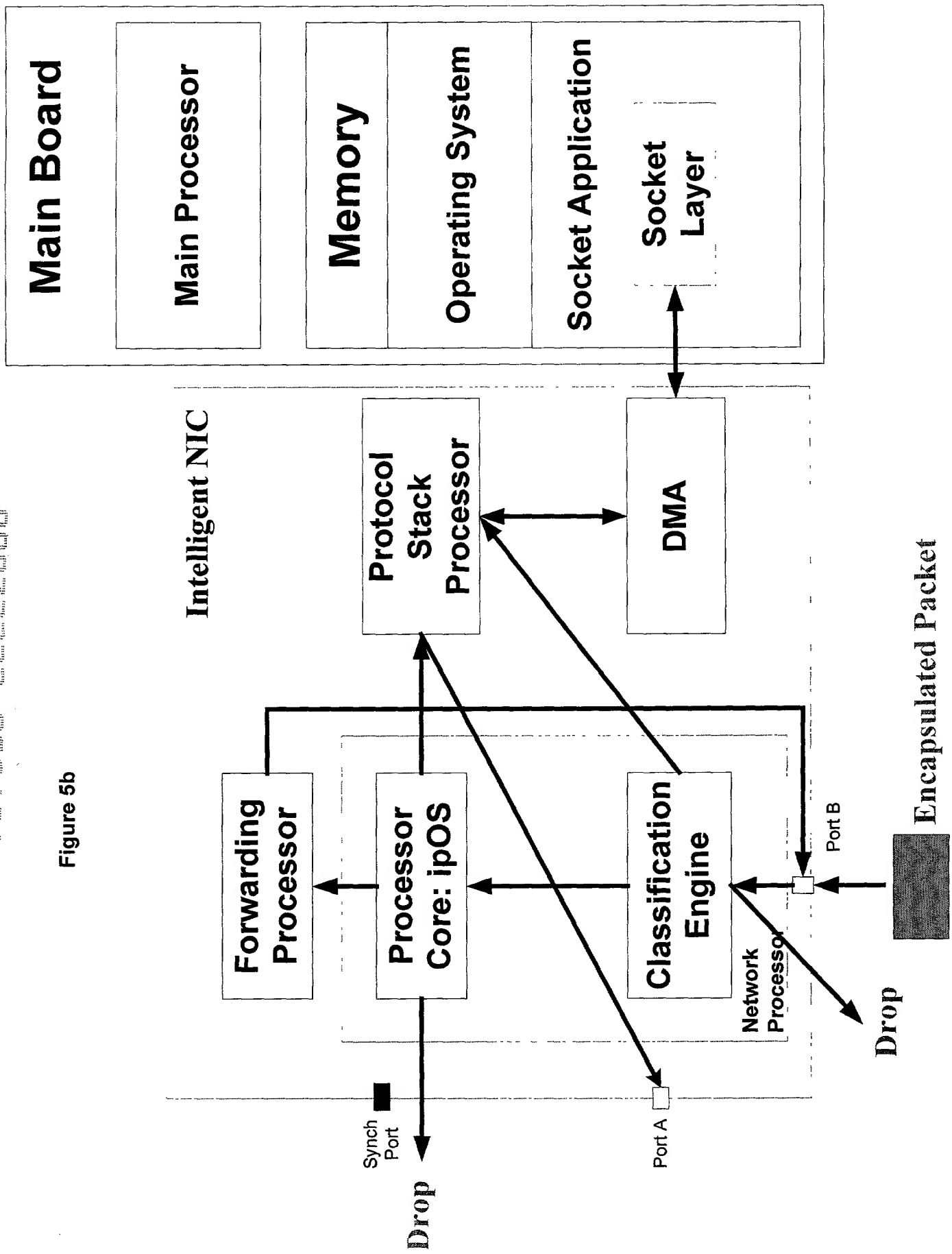
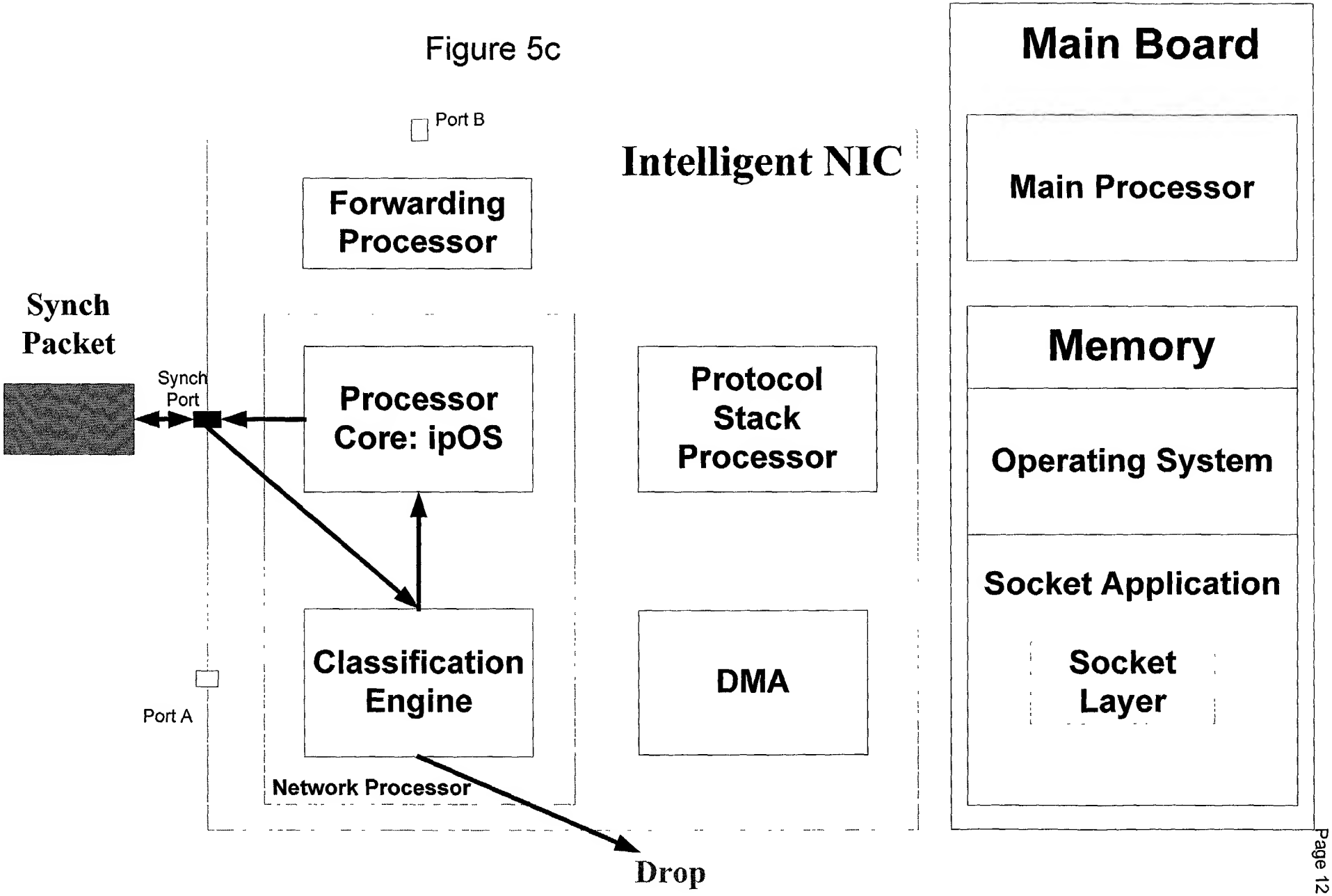

Main Board
Main Processor
Memory
Operating System
Socket Application
Socket Layer
Intelligent NIC
Protocol Stack Processor
DMA
Forwarding Processor
Processor Core: ipOS
Classification Engine
Network Processor
Port B
Encapsulated Packet
Drop
Synch Port
Port A
Drop

Figure 5b

Figure 5c


Main Board
Main Processor
Memory
Operating System
Socket Application
Socket Layer
Intelligent NIC
Port B
Forwarding Processor
Synch Packet
Synch Port
Processor Core: ipOS
Protocol Stack Processor
Classification Engine
DMA
Port A
Network Processor
Drop

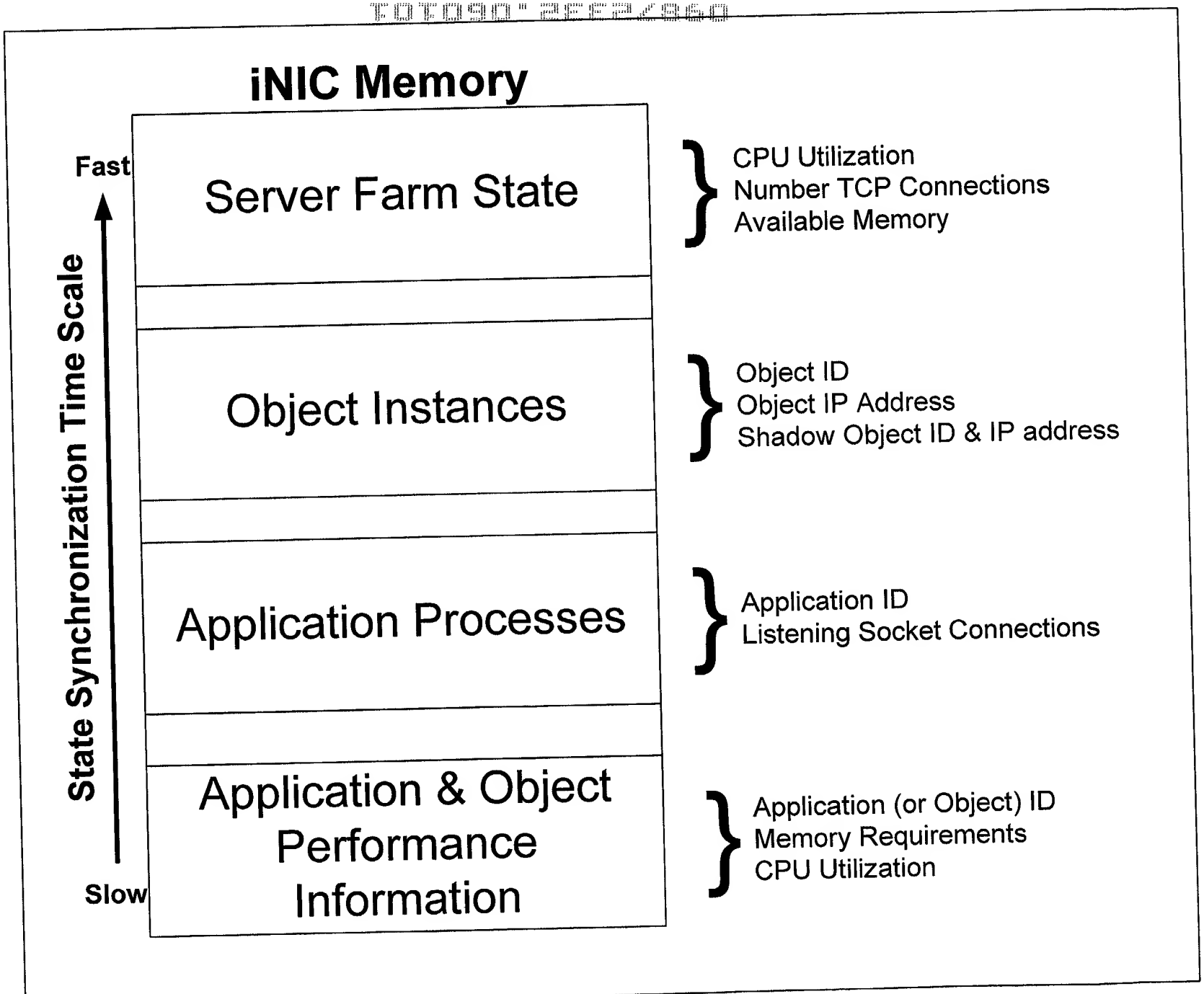
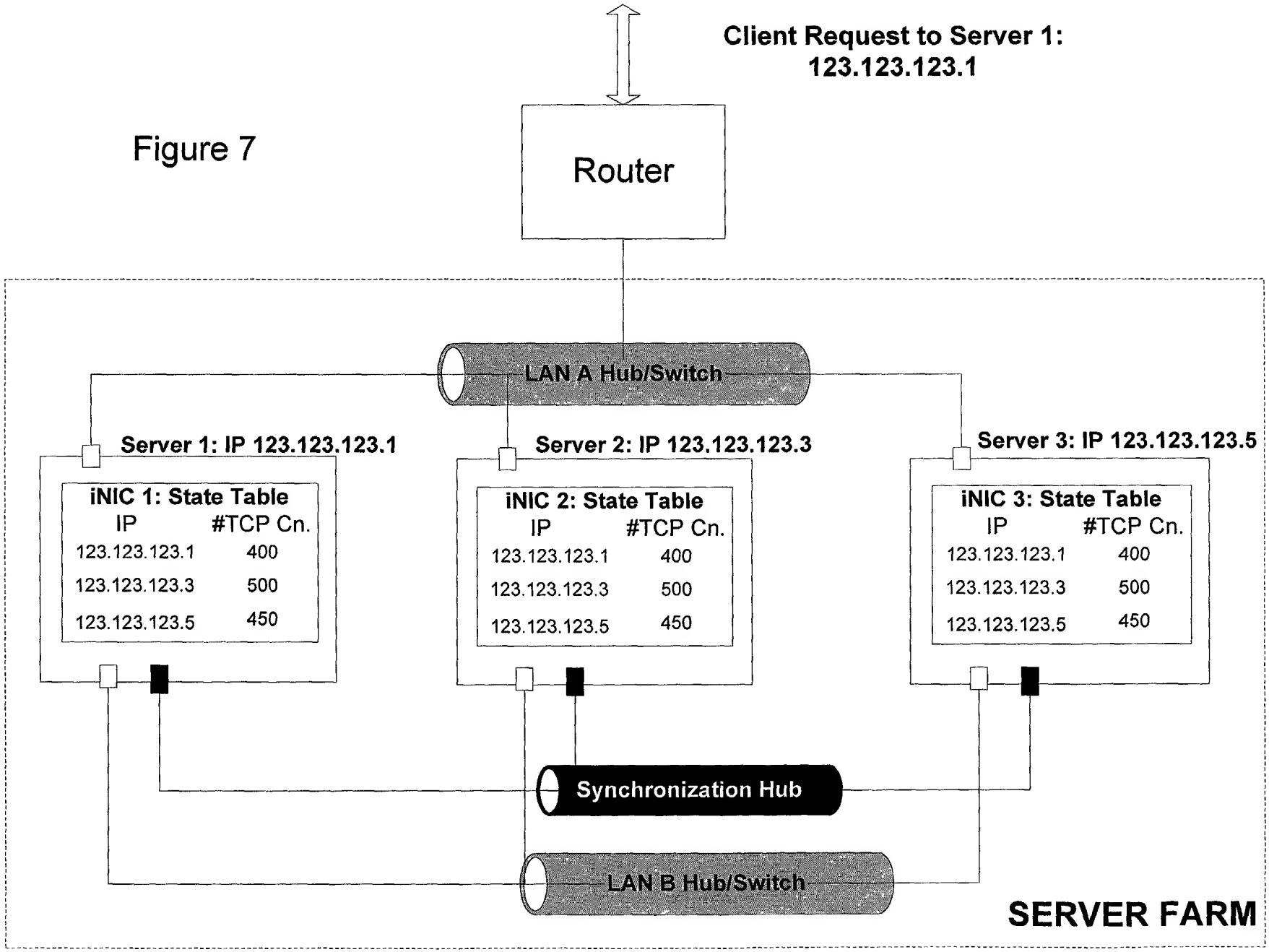

iNIC Memory
Fast
State Synchronization Time Scale
Slow
Server Farm State
Object Instances
Application Processes
Application & Object Performance Information
CPU Utilization
Number TCP Connections
Available Memory
Object ID
Object IP Address
Shadow Object ID & IP address
Application ID
Listening Socket Connections
Application (or Object) ID
Memory Requirements
CPU Utilization

Figure 6

Figure 7



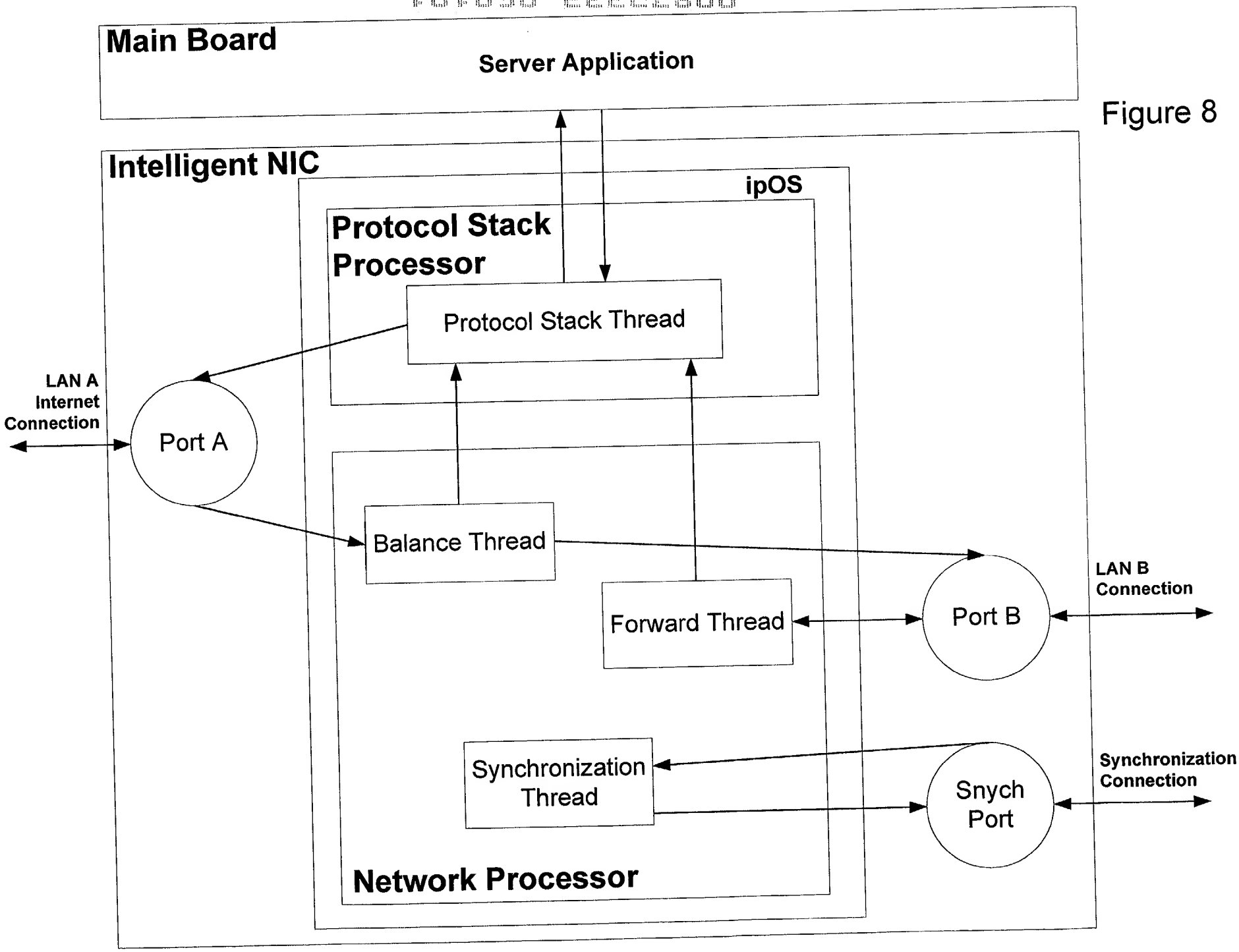


Figure 8

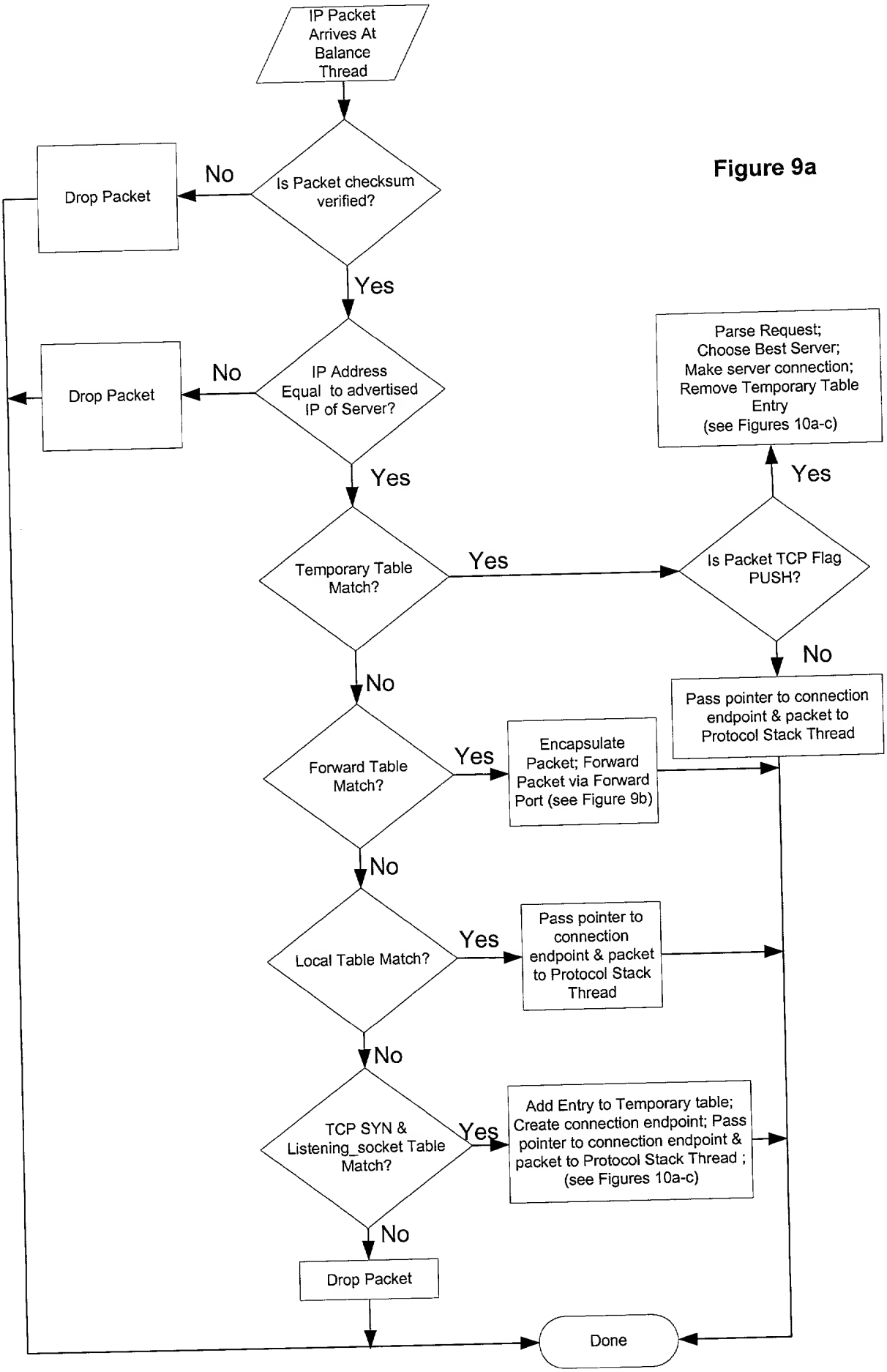

IP Packet Arrives At Balance Thread
Is Packet checksum verified?
No
Drop Packet
Yes
IP Address Equal to advertised IP of Server?
No
Drop Packet
Yes
Temporary Table Match?
Yes
Is Packet TCP Flag PUSH?
Yes
Parse Request; Choose Best Server; Make server connection; Remove Temporary Table Entry (see Figures 10a-c)
No
Pass pointer to connection endpoint & packet to Protocol Stack Thread
No
Forward Table Match?
Yes
Encapsulate Packet; Forward Packet via Forward Port (see Figure 9b)
No
Local Table Match?
Yes
Pass pointer to connection endpoint & packet to Protocol Stack Thread
No
TCP SYN & Listening_socket Table Match?
Yes
Add Entry to Temporary table; Create connection endpoint; Pass pointer to connection endpoint & packet to Protocol Stack Thread ; (see Figures 10a-c)
No
Drop Packet
Done

Figure 9a

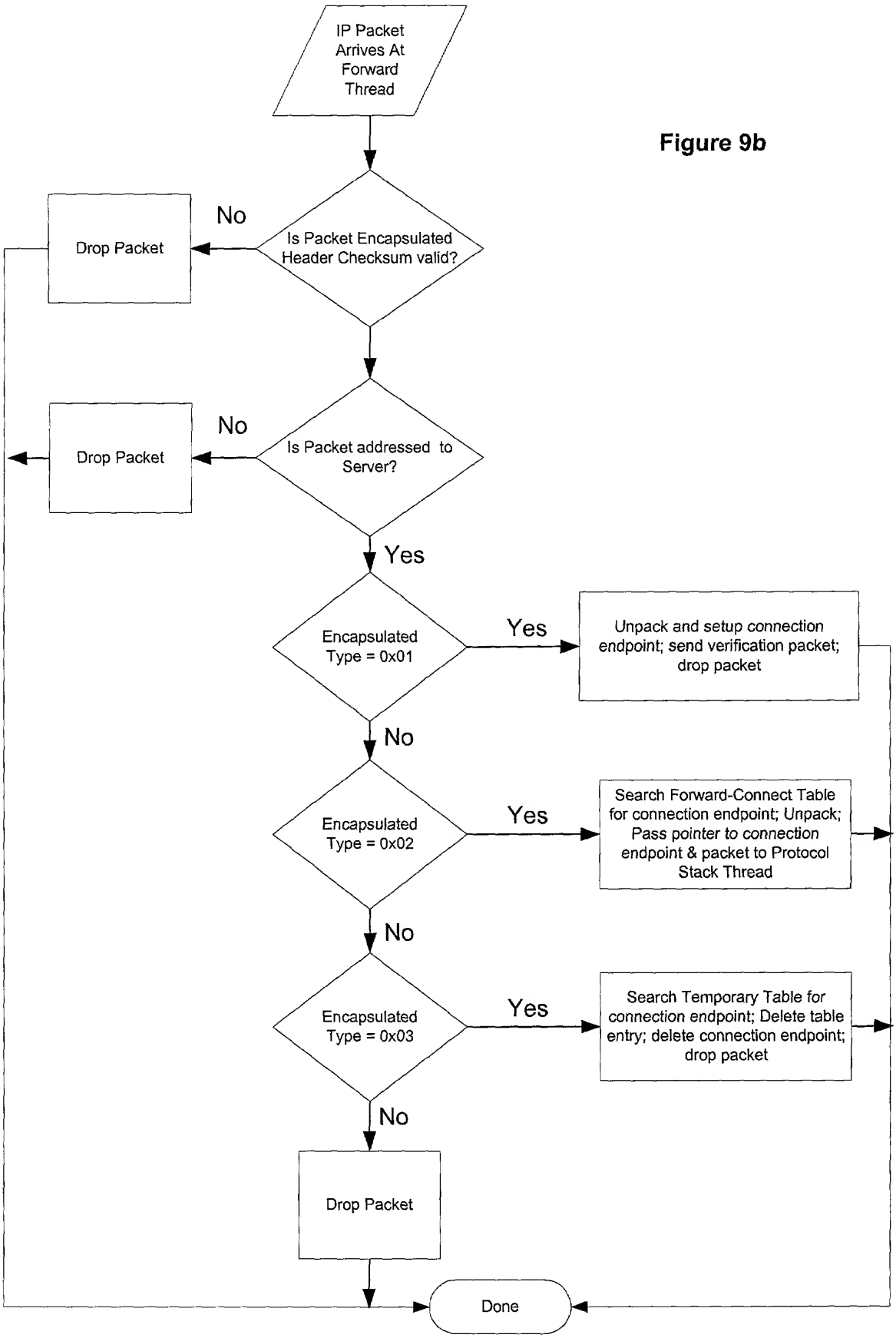
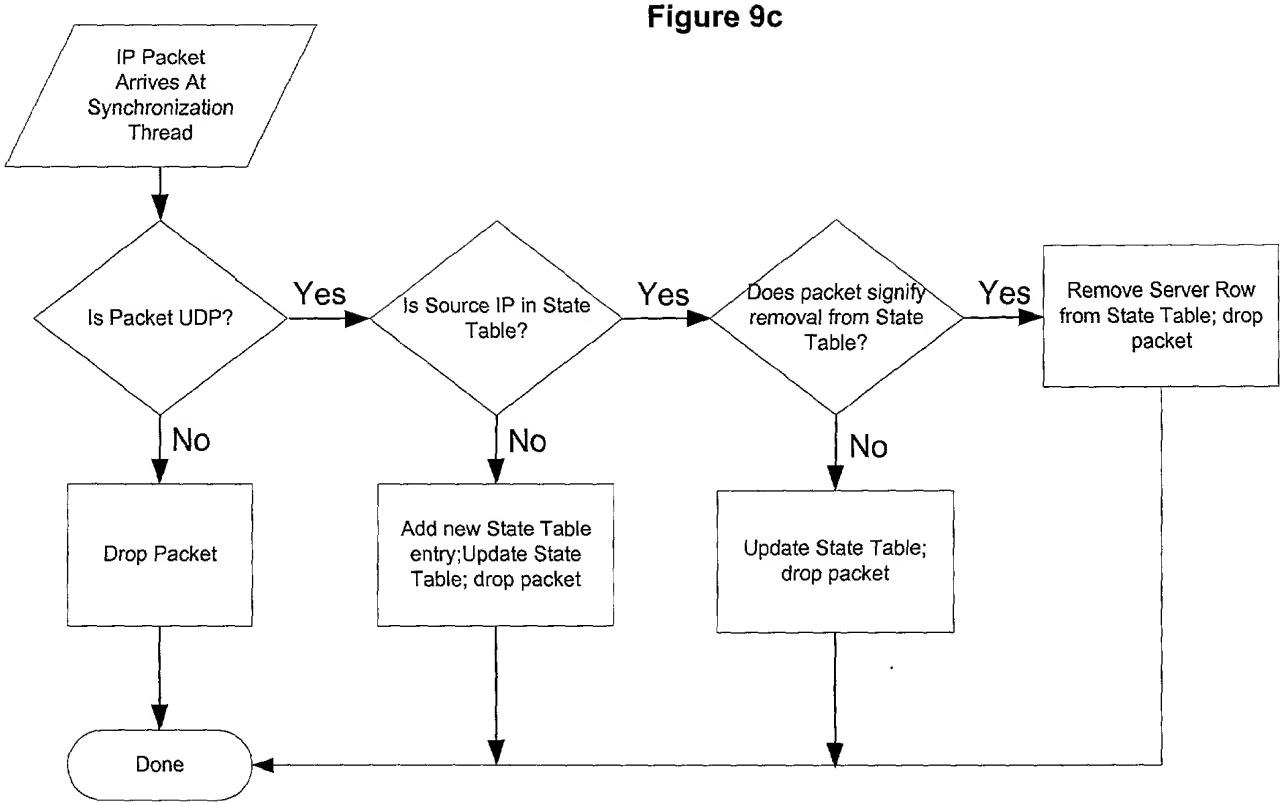


Figure 9b

Figure 9c


IP Packet Arrives At Synchronization Thread
Is Packet UDP?
Yes
Is Source IP in State Table?
Yes
Does packet signify removal from State Table?
Yes
Remove Server Row from State Table; drop packet
No
Drop Packet
No
Add new State Table entry;Update State Table; drop packet
No
Update State Table; drop packet
Done

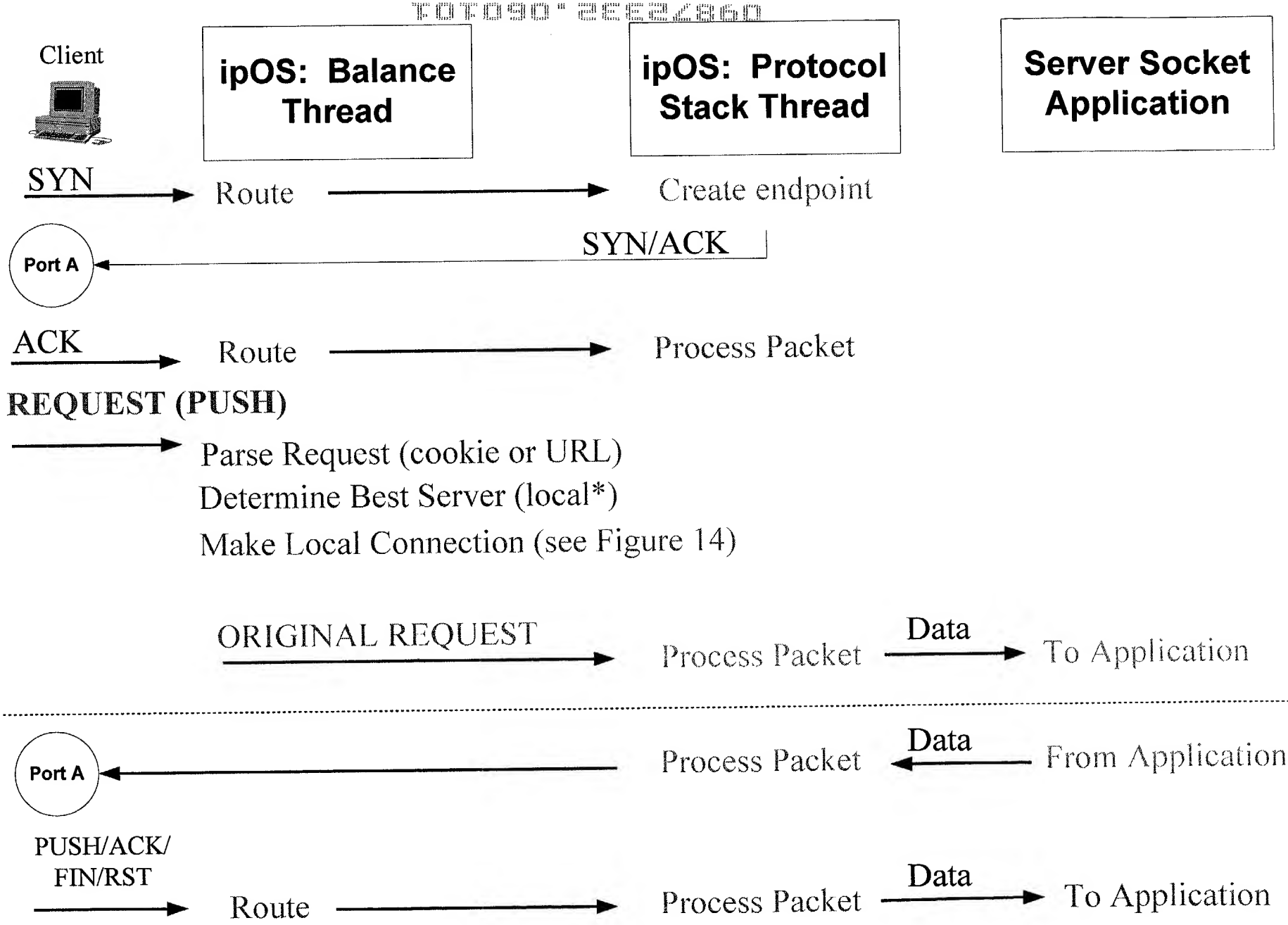

Client
ipOS: Balance Thread
ipOS: Protocol Stack Thread
Server Socket Application
SYN
Route
Create endpoint
SYN/ACK
Port A
ACK
Route
Process Packet
REQUEST (PUSH)
Parse Request (cookie or URL)
Determine Best Server (local*)
Make Local Connection (see Figure 14)
ORIGINAL REQUEST
Process Packet
Data
To Application
Port A
Process Packet
Data
From Application
PUSH/ACK/
FIN/RST
Route
Process Packet
Data
To Application

Figure 10a

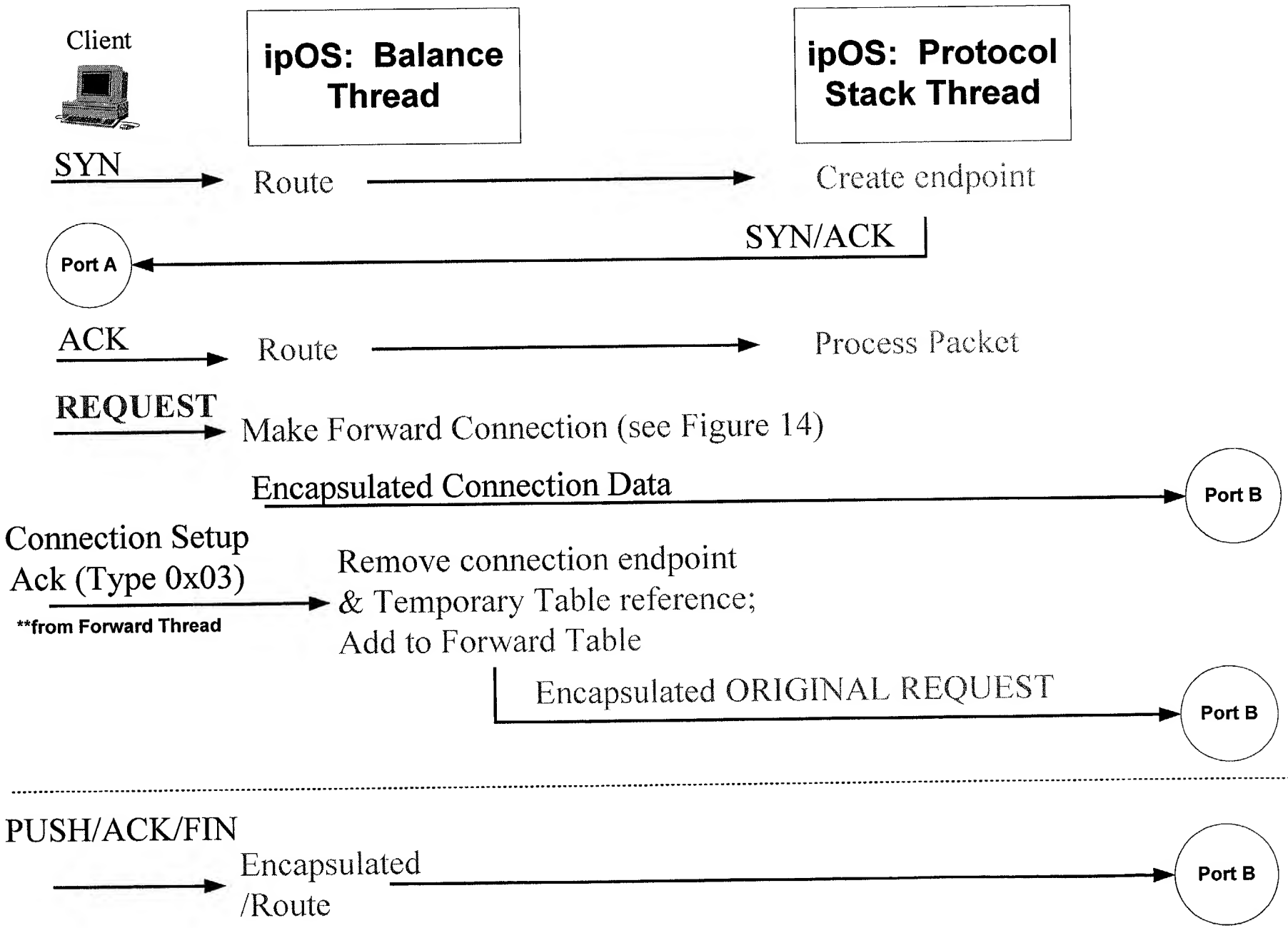

Client
ipOS: Balance Thread
ipOS: Protocol Stack Thread
SYN
Route
Create endpoint
SYN/ACK
Port A
ACK
Route
Process Packet
REQUEST
Make Forward Connection (see Figure 14)
Encapsulated Connection Data
Port B
Connection Setup Ack (Type 0x03)
**from Forward Thread
Remove connection endpoint & Temporary Table reference; Add to Forward Table
Encapsulated ORIGINAL REQUEST
Port B
PUSH/ACK/FIN
Encapsulated /Route
Port B

Figure 10b

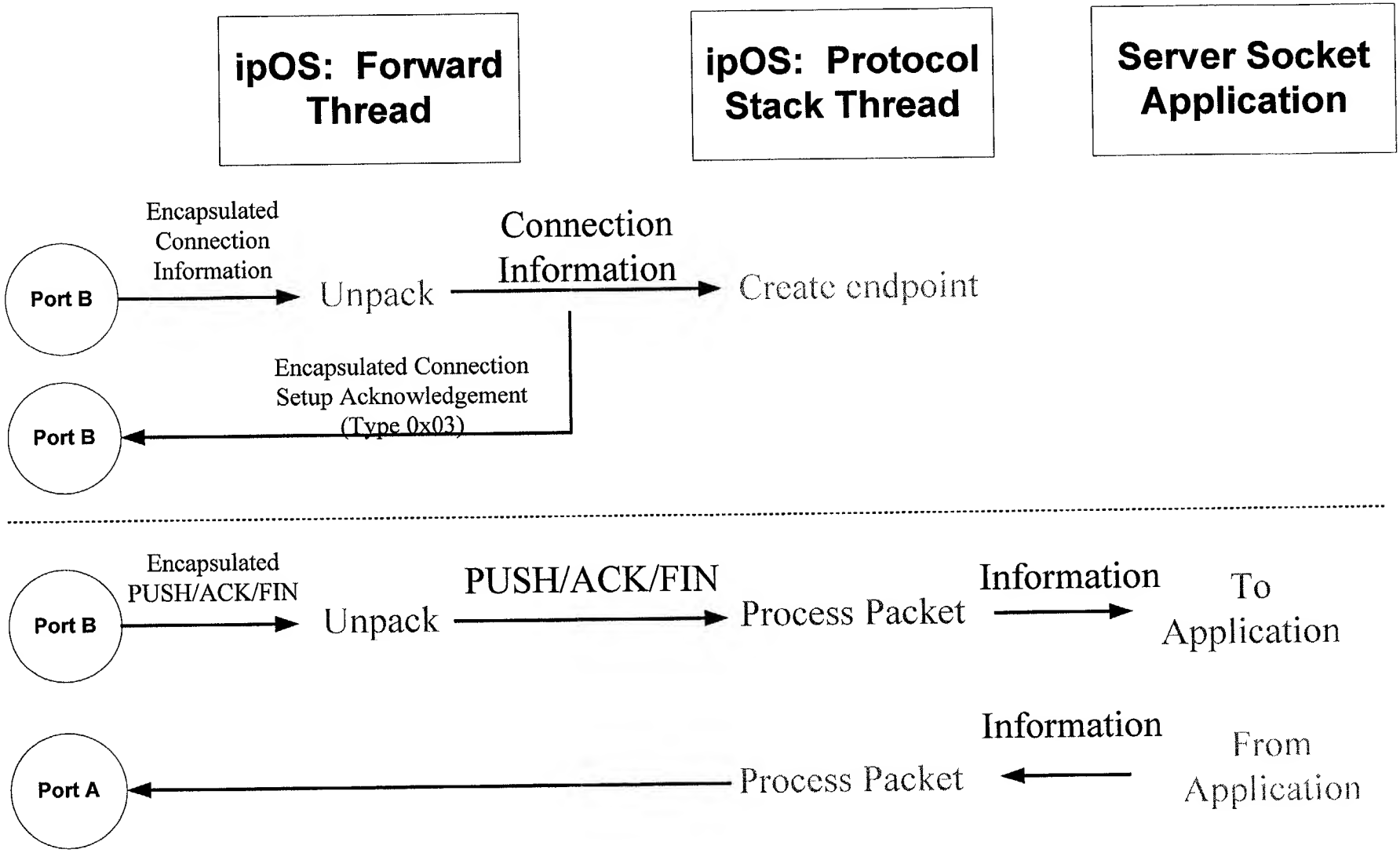

ipOS: Forward Thread
ipOS: Protocol Stack Thread
Server Socket Application
Encapsulated Connection Information
Port B
Unpack
Connection Information
Create endpoint
Encapsulated Connection Setup Acknowledgement (Type 0x03)
Port B
Encapsulated PUSH/ACK/FIN
Port B
Unpack
PUSH/ACK/FIN
Process Packet
Information
To Application
Information
From Application
Port A
Process Packet

Figure 10c

Ethernet Encapsulation Header

MAC Destination Address	MAC Source Address	Type 0x007
6	6	2

Figure 11a
(Prior Art)

ipOS Encapsulation Header

Source IP	Source Port	Dest. IP	Dest. Port	Type	Protocol	Checksum
4	2	4	2	1	1	2

Figure 11b

ipOS Connection Information (UDP)

Server IP	Server Port
4	2

Figure 11c

ipOS Connection Information (TCP)

Server IP	Server Port	TCP Control Block Information
4	2	140

Figure 11d

ipOS TCP Connection Packet (Type=0x01; Protocol=0x01)

Ethernet Encap. Type =0x007	ipOS Encap. Header	TCP ipOS Connection Information
14	16	146

Figure 11e

ipOS UDP Connection Packet (Type=0x01; Protocol=0x02)

Ethernet Encap. Type =0x007	ipOS Encap. Header	UDP ipOS Connection Information
14	16	6

Figure 11f

ipOS TCP Packet (Type=0x02; Protocol=0x01)

Ethernet Encap. Type =0x007	ipOS Encap. Header	IP/TCP Packet
14	16	40 + Data

Figure 11g

ipOS UDP Packet (Type=0x02; Protocol=0x02)

Ethernet Encap. Type =0x007	ipOS Encap. Header	IP/UDP Packet
14	16	28 + Data

Figure 11h

ipOS Endpoint Migration Acknowledgement Packet (Type=0x03)

Ethernet Encap. Type =0x007	ipOS Encap. Header
14	16

Figure 11i

Forward Table

Key	Field	Description
Yes	Source IP Address	IP address of Client
Yes	Source TCP Port	TCP Port of Client
No	Destination IP Address	IP Address to Forward
No	Destination TCP Port	TCP Port to Forward

Local/Forward-Connect/Temporary Table

KEY	Field	Description
Yes	Source IP Address	Client IP address
Yes	Source Port	Client TCP Port
Yes	Destination IP Address	Endpoint IP Address
Yes	Destination Port	Endpoint TCP Port
No	Endpoint Reference	Reference to Connection Endpoint

Server State Table

Key	Field	Description
Yes	Server IP Address	Server
No	Number TCP Connections	TCP Established Connections
No	CPU utilization	Main board CPU utilization
No	Available memory	Unused memory on Main Board
No	Available Bandwidth	Unused Bandwidth Capacity

Listening Sockets Table

Key	Field	Description
Yes	Server IP Address	Server
Yes	TCP Port	Advertised TCP Port
No	Process	Application process advertising IP/Port

Application Information Table

Key	Field	Description
Yes	Process ID	Application identification
No	Process memory requirements	Memory required to run application
No	Process CPU Utilization	Measure of application CPU utilization

URL Map Table

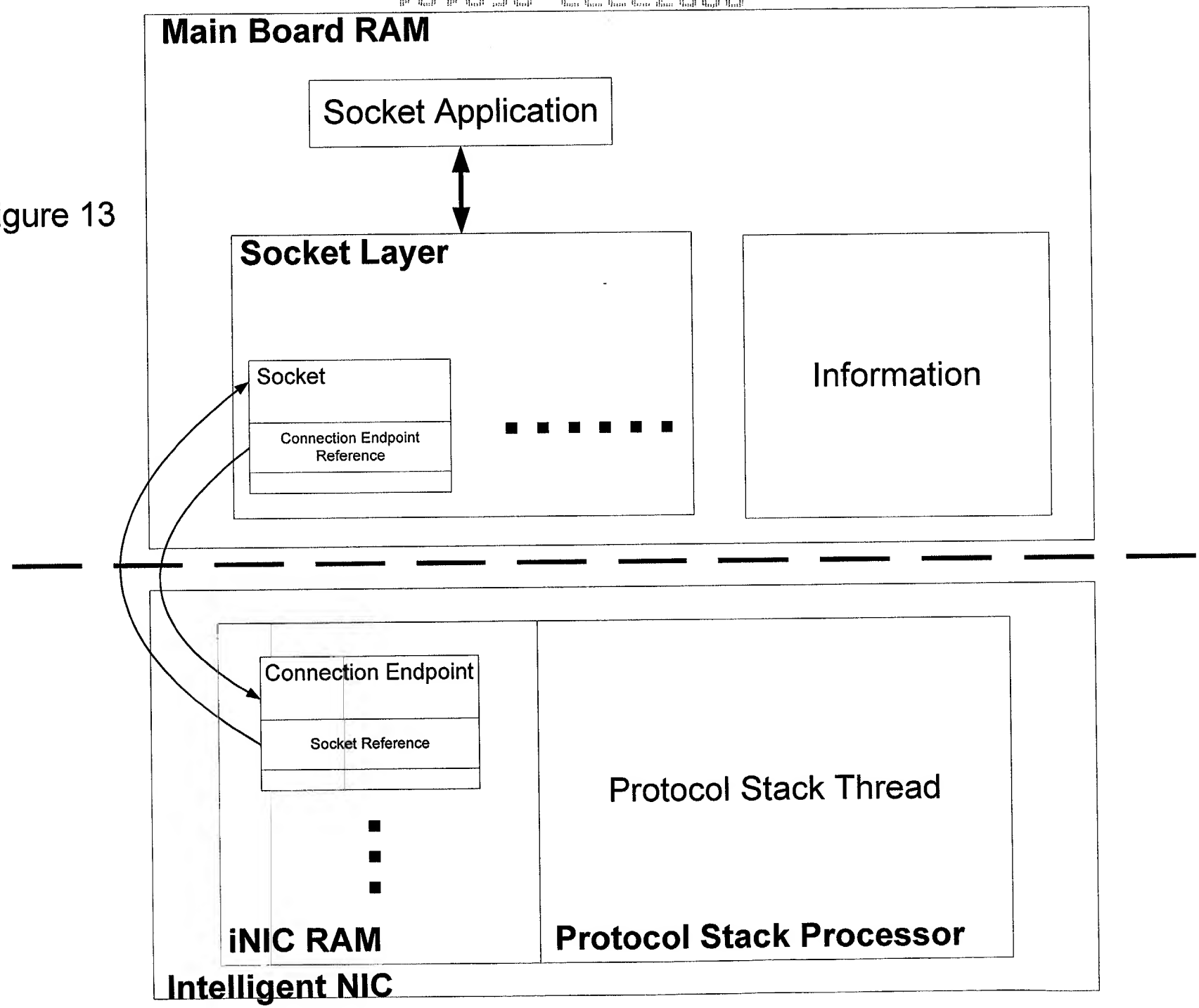
Key	Field	Description
Yes	URL	Universal Resource Locator
Yes	Server IP Address	IP address of associated server

Cookie Map Table

Key	Field	Description
Yes	Cookie ID	Cookie Identification tag
No	Server IP Address	IP address of associated server

Figure 12

Figure 13


Main Board RAM
Socket Application
Socket Layer
Socket
Connection Endpoint Reference
Information
Connection Endpoint
Socket Reference
Protocol Stack Thread
iNIC RAM
Protocol Stack Processor
Intelligent NIC

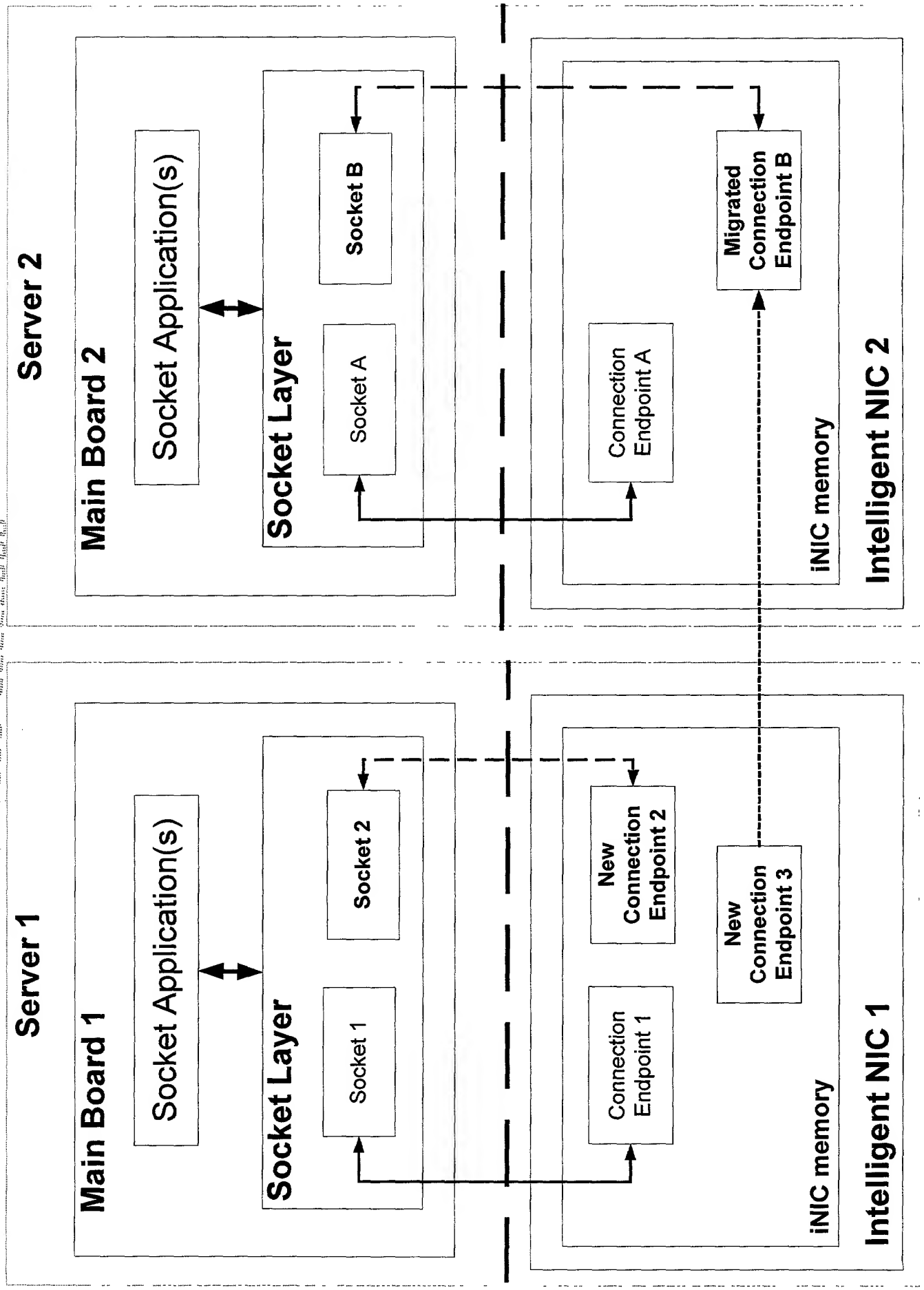

Server 1
Main Board 1
Socket Application(s)
Socket Layer
Socket 1
Socket 2
Intelligent NIC 1
iNIC memory
Connection Endpoint 1
New Connection Endpoint 2
New Connection Endpoint 3
Server 2
Main Board 2
Socket Application(s)
Socket Layer
Socket A
Socket B
Intelligent NIC 2
iNIC memory
Connection Endpoint A
Migrated Connection Endpoint B

Figure 14

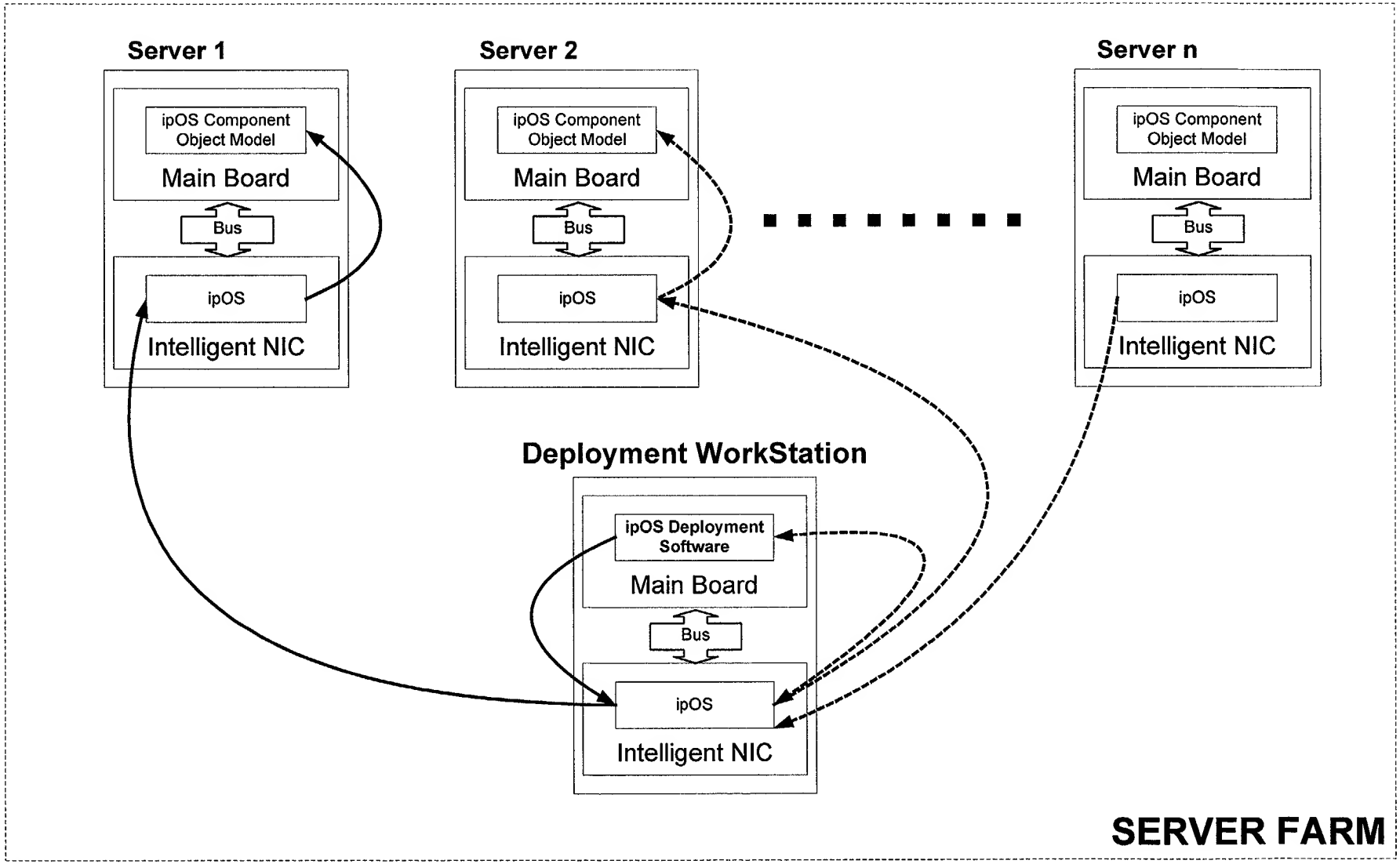

Server 1
ipOS Component Object Model
Main Board
Bus
ipOS
Intelligent NIC
Server 2
ipOS Component Object Model
Main Board
Bus
ipOS
Intelligent NIC
Server n
ipOS Component Object Model
Main Board
Bus
ipOS
Intelligent NIC
Deployment WorkStation
ipOS Deployment Software
Main Board
Bus
ipOS
Intelligent NIC
SERVER FARM

Figure 15

Figure 16

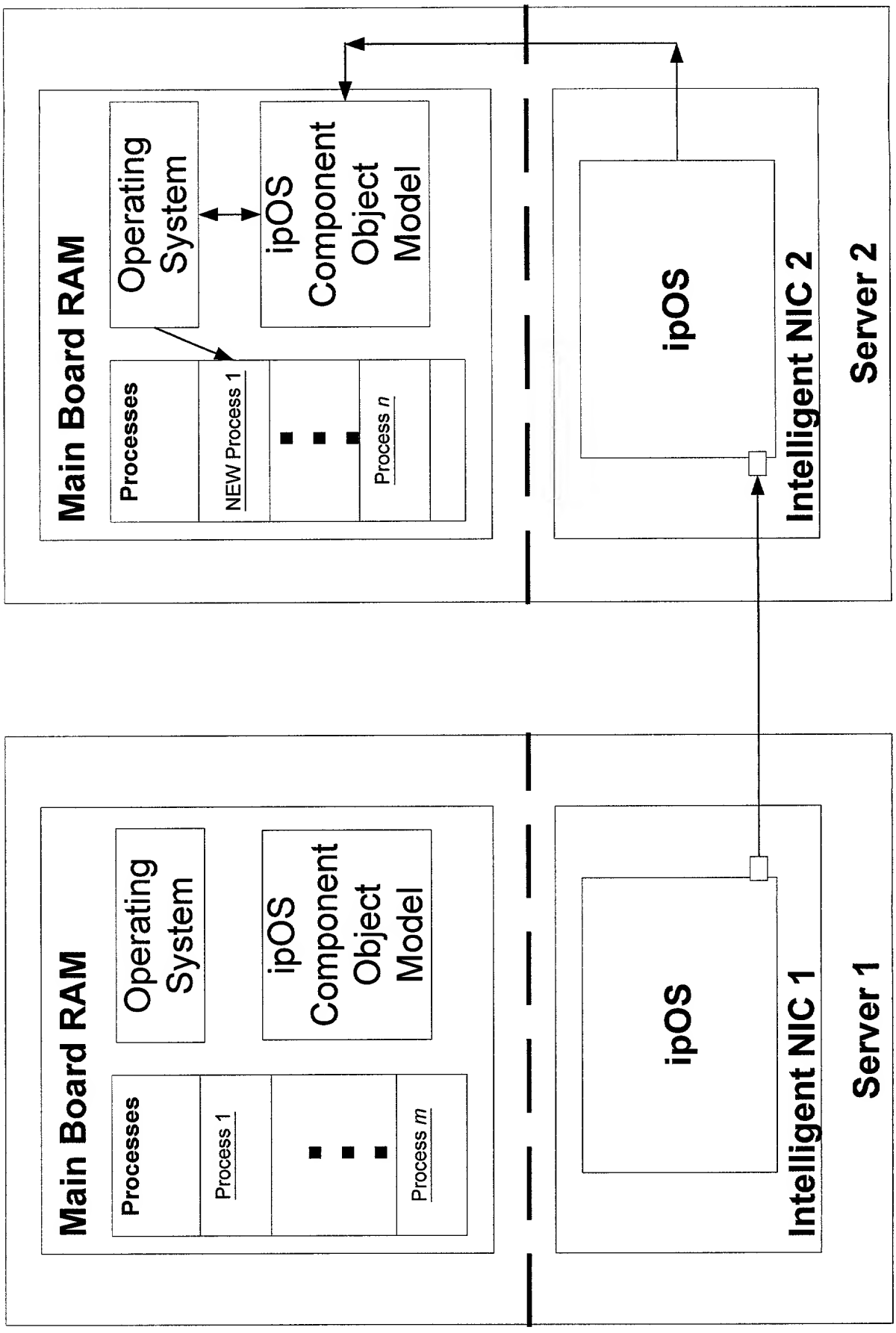
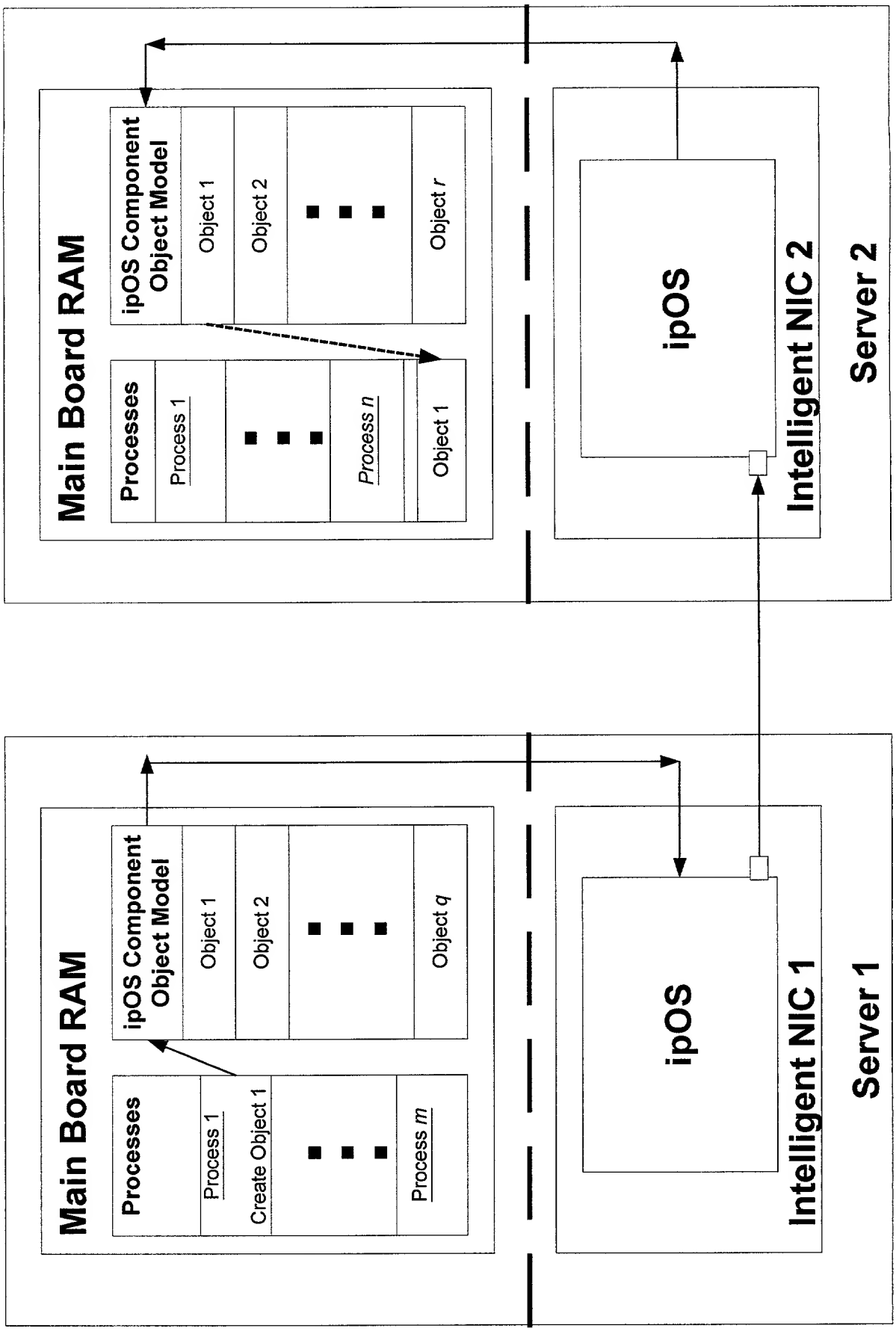


Figure 17


Server 1
Intelligent NIC 1
ipOS
Main Board RAM
Processes
Process 1
Create Object 1
Process m
ipOS Component Object Model
Object 1
Object 2
Object q
Server 2
Intelligent NIC 2
ipOS
Main Board RAM
Processes
Process 1
Process n
Object 1
ipOS Component Object Model
Object 1
Object 2
Object r